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GB 2003923 A GB 0970739 A EP 0403306 A1
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(54) Lubricants for aluminium alloy forging

(57) A lubricant for aluminium alloy forging comprises a mixture of an inorganic lubricant base material plus an organic component to impart spreading and adhesive properties to the lubricant base. Lubricant is a powder or the base may be coated with the organic compound. Inorganic base is e.g. a baron or silicon nitride, metal oxide, talc or mica etc. Organic component is e.g. a metal soap, a polymer, oil, fat or a glycol etc.

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POWDERY LUBRICANT FOR ALUMINUM ALLOY FORGING

This invention relates to a powdered lubricant for alloy forging for use in cold, warm or hot forging work, preferably use for with an aluminum alloy. The lubricant is used by being sprayed onto metal molds or such aluminum alloys by a conventional spraying method or an electro-static spraying method.

Forged products are frequently used for various parts in airplanes, automobiles, electric equipment etc. Choice of materials for these parts is now changing from iron to light alloys, for example aluminum alloys, in order to meet the demand for reducing the weight of the material. In the forging work or process, a lubricant or lubricating oil is disposed between the metal mold and the material so as to avoid deposition between them and to improve separation ability of the forged part from the metal mold.

Oil-soluble lubricants with added graphite and water-soluble lubricants consisting of synthetic esters, silicone oils, graphite, extreme-pressure additives and surface active agents are generally used as lubricants in aluminum alloy forging.

In recent years, the demand for products of high quality and with good workability has increased with the reduction in weight of various parts and aluminum alloy forging technology. It is difficult to satisfy such demands by using conventional lubricants. In this respect, the oil-soluble lubricants have disadvantages such as smoking, causing workshop contamination, risk of flammability etc. Furthermore, the water-soluble lubricants have disadvantages including the requirement for treatment of waste water to control water-pollution after use thus resulting in cost increases for plant and equipment investment etc.

Accordingly, the need for a new type of lubricant

particularly for aluminum alloy forging has arisen.

This invention has been made on the basis of detailed studies and systematic experiments in due consideration of the foregoing situations. An object of this invention is to provide a powdery lubricant, preferably for aluminum alloy forging, for obtaining forging products of higher quality with better workability and without detriment to environmental conditions in aluminum alloy forging work.

According to the invention there is provided a powdered lubricant for alloy forging which comprises a mixture of a lubricant base material which is an inorganic compound with an organic compound imparting an adhesive property to the lubricant base material, wherein either both the compounds have powdered or granulated form, or the lubricant base material is coated with the organic compound. The lubricant is particularly appropriate for use in aluminum alloy forging.

It is a particular feature of this invention that the lubricant base material is of powdered or granulated form.

It is effective to select an organic compound in an amount of, in relation to an inorganic compound, from 0.1 up to 50 weight percent. This amount is preferred because the adhesive effect of the inorganic compound to metal mold insides is not so satisfactory when the content is less than 0.1 weight percent. Conversely, smoking and build-up occurs so that there is a difficulty in removing the forging product from the metal mold insides, i.e. a decrease in lubricating efficiency or a worsening of dimensional accuracy of the molded product when the content of the organic compound is greater than 50 weight percent.

There is no limitation as regards the lubricant base materials for use in the present invention, provided that they comprise a solid inorganic compound as a lubricant.

Generally, any of the following: a boron nitride, fluoride, talc, mica, metal oxide, silicon nitride, boron compound, sulfur compound and/or a phosphorus compound, are preferred. However other well known solid lubricants which have conventionally been used as lubricants may be used, such as graphite, molybdenum disulfide etc. These inorganic compounds have powdery or granulated form, and either one substance is used or two or more substances of those just mentioned are used in combination.

Further, there is no special limitation as regards the organic compounds suitable for use in the present invention, provided they have characteristics of imparting adhesive and spreading properties to the foregoing inorganic compounds. Generally metal soaps, high molecular weight/polymeric compounds and liquid-form or paste-form compounds which are powdered or granulated suitably by a cyclodextrin compound are preferred. Carboxylic acid constructions annexed with sodium, calcium, aluminium, barium, lithium, potassium, magnesium or zinc may be suitable as the metal soap. Polyethylene, polypropylene, epoxy resin, silicon resin, natural wax, phenol resin, acrylic resin, alkyd resin, urethane resin, styrene resin or fluoro resin may be used as suitable high molecular weight/polymeric compounds. Synthetic esters, natural fats, mineral oils, silicon oils, polyphenyl ethers, polyalkylene glycols or ethylene-propylene copolymers are preferably used as the compound in liquid-form or paste-form. These organic compounds are either mixed with a lubricant base material when in a powdery or granulated form or, alternatively, mixed with the base material when in a heated molten state. Accordingly, in a lubricant according to the present invention, either both the lubricant base material and the organic compound are in a powdery or granulated form, or the powdery or granulated lubricant base material is coated with the organic compound.

The above-mentioned organic compounds maybe used either alone or in combination. Suitably, a combination of a metal

soap, high molecular compound, and powdered liquid-form or paste-form compound may be used.

In a powdery lubricant for aluminum alloy forging according to embodiments of the present invention, the lubricant base material at least has a powdery form or a granulated form. As a result the lubricant is hard to solve even when heat is applied to it during the forging processes and the forged product may be readily removed from the metal mold. Also gas may be prevented from being caught or trapped in the forged product so that accuracy and quality of products can be improved.

Further, since the lubricant of the present invention has a powdery or granulated form and includes little or no water, it does not pollute the water supply after use, which is a disadvantage associated with water-soluble lubricants. In addition it does not contaminate the work environment, in contrast to oil-soluble lubricants. Accordingly, waste water treatment and the prevention of environmental contamination may become unnecessary resulting in a decrease in expenditure. Also, since the lubricant of this invention includes no oily material, risk of smoking and fire and the like are reduced so that the lubricant is safer to use.

Moreover, since the lubricant base material, at least, is in powdery or granulated form in the lubricant of this invention, the material (aluminum alloy) is securely separated from the metal mold inside by a clearance corresponding to at least a grain diameter of powder or a granule of the lubricant base material, around a portion of the metal mold interior to which the lubricant adheres. The lubricant adheres uniformly to the inside of the metal mold so that direct contact of the material with the interior of metal mold may be avoided, deposition during plastic deformation may be prevented, wear on metal mold may be controlled, and workability may be improved.

According to the present invention, a lubricant for aluminum alloy forging consisting of a mixture of an organic compound and a lubricant base material which comprises an inorganic compound, is made into a lubricant such that at least the lubricant base material is of powdery or granulated form. Therefore, the deformation rate of an aluminum alloy during plastic deformation may be reduced or minimized, deposition may be prevented, and forged parts of high quality can be produced. Furthermore, environmental pollution before and after use may be more fully controlled.

Most especially, the quality of obtained forging products can be improved by employing organic compounds in relation to inorganic compounds in the range of 0.1 to 50 weight percent. Furthermore the above-mentioned effect can be particularly enhanced by employing a boron nitride, fluoride, talc, mica, metal oxide, silicon nitride, boron compound, sulfur compound and/or a phosphorus compound as the inorganic compound; and by employing a metal soap comprising a carboxylic acid salt with sodium, calcium, aluminium, barium, lithium, potassium, magnesium or zinc, or a high molecular weight or polymeric compound such as polyethylene, polypropylene, epoxy resin, silicon resin, natural wax, phenol resin, acrylic resin, alkyd resin, urethane resin, styrene resin and/or fluoro resin as the organic compound; and by employing synthesis esters, natural fats, mineral oils, silicon oils, polyphenyl ethers, polyalkylene glycols or ethylene-propylene copolymers as a liquid-form or paste-form compound powdered or granulated by a cyclodextrin compound. The most suitable lubricants in respective forging works are obtainable by using two or more kinds of the foregoing inorganic compounds and organic compounds respectively in combination.

EXAMPLES

Embodiments of the present invention will be described below but the invention is not limited to these embodiments.

The following lubricants (A) through (G) were prepared Aluminum alloy forging tests based on the forging method were carried out by using these lubricants, and items listed in the TABLE were compared and examined. In the tests, JIS 2014 high tensile alloy was used, the forging temperature was 390°C, and the lubricant was sprayed by the electrostatic spray method.

Two kinds of mixtures were prepared: Firstly, a mixture of an organic compound with an inorganic compound both in powdery or granulated form, and, secondly, a mixture wherein the organic compound is mixed with the inorganic compound in a heated molten state; for the embodiments (A) through (D) of the present invention.

The two kinds of mixtures were examined and results obtained were the same for both mixtures. Incidentally, an organic compound, in which natural fat was powdered by an experimental method using cyclodextrin compound, was used for the organic compound in the lubricant (D) but other compounds were purchased from the market.

(A) First embodiment of this invention composed of a mixture of 90 parts of mica (mean particle size; 6 microns) and 10 parts of polyethylene

(B) Second embodiment of this invention composed of a mixture of 10 parts of boron nitride, 60 parts of mica and 30 parts of calcium stearate

(C) Third embodiment of this invention composed of a mixture of 70 parts of talc, 10 parts of silicon nitride, 10 parts of natural wax and 10 parts of zinc stearate

(D) Fourth embodiment of this invention composed of a mixture of 20 parts of boron nitride, 60 parts of talc, 5 parts of sodium borate and 15 parts of powdered natural fat

(E) Boron nitride only (comparison embodiment 1)

(F) Commercial lubricant for forging composed of mineral oil, natural fat and graphite (comparison embodiment 2)

(G) Commercial lubricant for forging composed of

carboxylate, synthetic wax, extreme-pressure additive and surface active agent (comparison embodiment 3).

[TABLE]

		This invention				Comparison		
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
Adhesion to metal mold		@	@	@	@	x	o	*
Influence on quality	Effect for preventing deposition	@	@	@	@	-	o	*
	Effect for preventing underfill	@	@	@	@	-	o	x
	Effect for preventing cracks	@	@	@	@	-	o	x
	Effect for improving quality of forging surface	@	o	@	o	-	o	*
	Effect for preventing defect by oil	@	@	@	@	-	x	*
Effect for preventing worsening of field environment due to generation of smoke and steam		@	@	@	@	-	x	*

x: None, -: Measurement impossible,

*: Small, o: Intermediate, @: Large

CLAIMS

1. A lubricant for aluminum alloy forging, comprising a mixture of a lubricant base material which is an inorganic compound and an organic compound which imparts adhesive property to the lubricant base material, wherein either both the base material and the inorganic compound are in powdered or granulated form, or the base material is coated with the organic compound.

2. A lubricant according to claim 1, which contains the organic compound at a content of from 0.1 to 50 weight percent in relation to the inorganic compound.

3. A lubricant according to claim 1 or 2, wherein the inorganic compound is one or more of a boron nitride, a fluoride, talc, mica, a metal oxide, a silicon nitride, a boron compound, a sulfur compound and a phosphorus compound.

4. A lubricant according to any preceding claim wherein the organic compound comprises at least one of a metal soap, a high molecular weight/polymeric compound and a liquid-form or paste-form compound which is powdered or granulated by a cyclodextrin compound.

5. A lubricant according to claim 4, wherein the metal soap comprises a carboxylic acid salt of sodium, calcium, aluminium, barium, lithium, potassium, magnesium or zinc.

6. A lubricant according to claim 4, wherein the high molecular compound comprises a polyethylene, a polypropylene, an epoxy resin, a silicon resin, a natural wax, a phenol resin, an acrylic resin, an alkyd resin, a urethane resin, an styrene resin or a fluoro resin.

7. A lubricant according to claim 4, wherein the liquid-form or paste-form compound comprises a synthetic ester, a natural fat, a mineral oil, a silicon oil, a polyphenyl ether, a polyalkylene glycol or an ethylene-propylene copolymer.

8. A lubricant substantially as hereinbefore described with reference to any one of Examples A to D.

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Relevant Technical fields

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Databases (see over)

(i) UK Patent Office

(ii) ON LINE DATABASES: WPI AND CLAIMS

Date of Search

13 MARCH 1992

Documents considered relevant following a search in respect of claims 1-8

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB A 2227022 (HANANO) See whole document	1-8
X	GB A 2131828 (SEIKO SHO) See Claim 1	1, 3, 6
X	GB A 2016040 (MITSUBISHI) See Claims 1, 6	1, 3, 4, 6
X	GB A 2003923 (FOSECO) See Claims 1-11. Page 1 lines 124-127	1, 2, 3, 5, 7, 8
X	GB A 970739 (MIN. AVIATION) See whole document	1, 4, 5
X	JP B 87034360 (NIPPON STEEL) See dewent WPI Accession No. 84-052719/09	1, 6
X	EP A1 0403306 (CASTROL) See whole document	1-8
X	EP A2 0153039 (DOWA) See Claim 10	1, 6
X	EP A1 0007793 (TRW) See Examples 3-5. Page 3 last paragraph	1, 3

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Category	Identity of document and relevant passages	Rele t to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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